UNIVERSITI PUTRA MALAYSIA

STUDIES ON THE IMPROVEMENT OF THE NUTRITIVE VALUE AND UTILIZATION OF PALM KERNEL CAKE AS A FEED RESOURCE FOR RUMINANTS

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By

CHARURAT CHINAJARIYAWONG

Thesis Submitted in Fulfillment of the Requirements for the Degree of Doctor of Philosophy in the Institute of Bioscience Universiti Putra Malaysia

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MARCH 2000

Chairman: Professor Tan Sri Dato' Syed Jalaludin, Ph.D.

Faculty : Institute of Bioscience

Utilization of palm kernel cake (PKC) as the principal feed for ruminants was investigated in four studies. The study on the nutritive value showed that PKC-solvent extracted (PKC-S) and PKC-expeller pressed (PKC-E) contained similar amounts of OM, CP, CF and ADL. PKC-E had higher DM, EE and GE but lower NFE, NDF, ADF and shell contents. Amounts of Ca, P, Cu and Zn were similar in both types of PKC, but Na was higher and Mg was lower in PKC-S. Ruminal pH, NH_3-N concentration, molar proportions of VFA and passage rates of liquid and small digesta particles in cattle fed either PKC-S or PKC-E were similar. Total VFA concentration was higher in cattle fed PKC-S. Effective DM and OM degradabilities were lower in animals fed PKC-S, but degradation

rates were similar. PKC-E contained more soluble fractions than PKC-S. CP of PKC-S was more soluble, but its effective degradability and degradation rate were similar to that of PKC-E.

The study on the effects of formaldehyde treatments on CP degradability of both types of PKC showed that CP degradability decreased with increasing levels of formaldehyde. Acid-pepsin digestibility showed no difference in CP digestibility among untreated and formaldehyde-treated PKC up to 2.5g/100g CP.

The study on the effects of PKC and formaldehyde treatment on the performance and nutrient utilization of cattle showed that feed intake was lower in cattle fed PKC-E, but growth rates and feed per gain ratios did not differ from those fed PKC-S. Formaldehyde-treated (2g/100g CP) PKC gave poorer growth rates and feed conversion ratios when compared to untreated PKC. Types of PKC and formaldehyde treatment did not affect the nutrient digestibility, but PKC-E gave lower N retention. Formaldehyde had no effect on N retention.

In the final study, lambs fed PKC + 15% grass showed improvement in intakes and growth rates. Urea at either 0.5 or 1.0%, had no effect on feed intakes and feed conversion ratios. However, growth rates of lambs fed PKC + 0.5% urea were higher compared to other groups. Lambs fed PKC plus 15% grass and 0.5% urea had the highest intake and growth rate. Carcass traits were not affected by urea but grass supplementation reduced dressing percent and kidney fat of lambs.

Abastrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

KAJIAN KE ATAS PENINGKATAN PEMAKANAN DAN PENGGUNAAN MEAL ISIRONG KELAPA SAWIT SEBAGAI SUMBER MAKANAN UNTUK RUMINAN

Oleh

CHARURAT CHINAJARIYAWONG

MAC 2000

Pengerusi: Profesor Tan Sri Dato' Syed Jalaludin Syed Salim, PhD

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Kajian penggunaan meal isirong kelapa sawit (PKC) sebagai komponen utama ruminan telah dijalankan. Dari kajian nilai pemakanan menunjukkan nilai pemakanan 'PKC-solvent extracted' (PKC-S) dan 'PKC-expeller extracted' (PKC-E) mengandungi kandungan OM, CP, CF and ADL yang sama. PKC-E mengandungi jumlah DM, EE dan GE yang tinggi tetapi NFE, NDF, ADF dan kandungan tempurung yang rendah. Jumlah Ca, P, Cu dan Zn pada kedua-dua jenis PKC adalah sama tetapi amaun Na lebih tinggi dan Mg lebih rendah pada PKC-S. Nilai pH rumen, kepekatan NH_3-N, peratus molar VFA, kadar pengaliran bendalir dan partikel halus pada lembu yang diberi makan PKC-S dan PKC-E adalah sama. Jumlah kepekatan VFA lebih tinggi pada lembu yang diberi PKC-S. Degradasi efektif DM dan OM lebih rendah pada haiwan yang diberi PKC-S tetapi kadar degradasi sama. PKC-E mempunyai nilai fraksi larut yang lebih tinggi dari PKC-S. CP PKC-S adalah lebih larut daripada PKC-E tetapi degradasi efektif dan kadar degradasi kedua-dua PKC adalah sama.

Kajian kesan formaldehid ke atas kadar degradasi CP bagi PKC-S dan PKC-E menunjukkan degradasi CP menurun dengan peningkatan tahap formaldehid. Penghadaman asid-pepsin menunjukkan tiada perbezaan pada penghadaman CP di antara PKC yang tidak dirawat dan PKC yang dirawat dengan formaldehid hingga 2.5g/100g CP.

Dalam kajian kesan PKC dan rawatan formaldehid ke atas prestasi dan pengambilan makanan pada lembu menunjukkan kadar pengambilan makanan yang rendah pada lembu yang diberi PKC-E tetapi kadar pertumbuhan dan nisbah makanan pertumbuhan tidak berbeza daripada lembu yang diberi PKC-S. Lembu yang diberi makan PKC yang dirawat formaldehid pada tahap 2g/100g CP menunjukkan kadar pertumbuhan dan nisbah penukaran makanan yang merosot dibandingkan dengan lembu yang diberi PKC tanpa rawatan. Jenis PKC dan rawatan fomaldehid tidak memberi kesan ke atas penghadaman nutrien tetapi lembu yang diberi PKC-E menunjukkan retensi nitrogen yang rendah. Rawatan formaldehid tidak memberi kesan terhadap retensi nitrogen.

Kajian terakhir menunjukkan peningkatan pengambilan makanan dan kadar pertumbuhan anak bebiri yang diberi PKC dan 15% rumput. Urea pada tahap 0.5 atau 1.0% tidak memberi kesan terhadap pengambilan makanan dan nisbah pertukaran makanan. Walaubagaimana pun, kadar pertumbuhan anak bebiri yang diberi PKC dan 0.5% urea lebih tinggi dibandingkan dengan dengan kumpulan yang lain. Anak bebiri yang diberi makan PKC serta 15% rumput dan 0.5% urea menunjukkan pengambilan makanan dan pertumbuhan yang tinggi. Ciri karkas tidak terjejas dengan penambahan urea tetapi penambahan rumput mengurangkan peratusan berat bersih dan lemak ginjal anak bebiri.

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I certify that an Examination Committee met on 9 March, 2000 to conduct the final examination of Charurat Chinajariyawong on her Doctor of Philosophy thesis entitled " Studies on the Improvement of the Nutritive Value and Utilization of Palm Kernel Cake as a Feed Resource for Ruminants" in accordance with Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and was accepted as fulfillment for the degree of Doctor of Philosophy.

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Date: 11 MAY 2000

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or currently submitted for any other degree at UPM or other institutions.

(CHARURAT CHINAJARIYAWONG)

Date: 9 / 3 / 2000

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ADF	- Acid detergent fibre
ADL	- Acid detergent lignin
AOAC	- Association Official Agricultural Chemists
ARC	- Agricultural Research Council
CF	- Crude fibre
CP	- Crude protein
DE	- Digestible energy
DGE	- Apparent digestibility of gross energy
DM	- Dry matter
DMI	- Dry matter intake
DMRT	- Duncan's multiple range test
DNI	- Digestible nitrogen intake
DOMI	- Digestible organic matter intake
EDTA	- Ethylenediamine tetraacetic acid
EE	- Ether extract
G	- Grass supplementation
GE	- Gross energy
HCHO	- Formaldehyde
ME	- Metabolisable energy

MRT	- Mean retention time
NDF	- Neutral detergent fibre
NFE	- Nitrogen free extract
NI	- Nitrogen intake
NRC	- National Research Council
OM	- Organic matter
PKC	- Palm kernel cake
PKC-E	- Palm kernel cake-expeller press
PKC-S	- Palm kernel cake-solvent extraction
POME	- Palm oil mill effluent
PPF	- Palm press fibre
SAS	- Statistical Analysis System
TCA	- Trichloroacetic acid
TDN	- Total digestible nutrient
TMRT	- Total mean retention time
TPKC-E	- Formaldehyde treated palm kernel cake-expeller press
TPKC-S	- Formaldehyde treated palm kernel cake-solvent extraction
TT	- Transit time
U	- Urea supplementation